When does a circle appear as a circle?

By Vortexpuppy

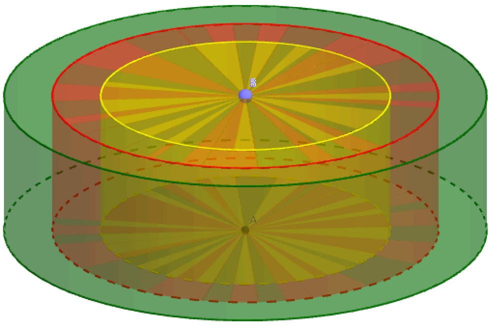
This inquiry is motivated by flat earth research. We seek to explain the appearance of the Sun assuming a flat earth model where the Sun is a flat circular disc that circles / spirals above us at a constant altitude around a fixed center, in a plane parallel to the level ground plane.

1.1. Flat Earth Model

The Sun measured using a sextant is 32 nautical miles wide, and estimated in the FE model to be 3200 miles in altitude.

The Sun moves in a plane that is parallel to the ground plane, so that the altitude of the Sun remains constant at the distance separating its plane of motion and the ground plane. The Sun moves between Cancer and Capricorn, circling the equator at the Spring and Autumn Equinox. At the summer solstice it is circling in Cancer and at the winter solstice it is circling in Capricorn. At the Equinoxes it crosses the Equator on its widening or narrowing spiral orbit.

We can visualize this as three concentric nested cylinders. Green is the Tropic of Capricorn, Red is the Equator and Yellow is the Tropic of Cancer. We live on that surface (islands in the water) on which the bottoms of the cylinders are resting.



Let an observer anywhere on the ground plane, see the Sun. It is then daytime and for a finite duration a finite area is illuminated with stronger or weaker light, that depending on the distance and position of the Observer with respect to the Sun, and the motion of the Sun between Cancer and Capricorn on the plane. The Sun's path is a planar spiral between Cancer and Capricorn as it turns wider or narrower circles during the year. The tropics are the boundary circles of this widening and narrowing. In German they are called a "Wendekreis", a turning-circle, for good reason. The Tropics are the circles where the Sun stops widening and begins narrowing or vice versa.

Question: Is the spiral path of the Sun, an equiangular spiral, or logarithmic spiral? This is a pre-dominant form in nature in a variety of living things. A Sunflower head has a spiral pattern that would appear to mimic the path of the Sun as the flowering eye follows the light. As above so below? Is it an arithmetic or geometric progression? Equal distances or

equal angles? Both are not possible simultaneously. Neither is knowing position and velocity according to Quantum mechanics probability cloud anyone?

We can only view the Suns path directly during the day if we physically make two right angle turns. We must turn to the East as it rises, then turn a right angle to the North/South when it is overhead and then another right angle to the West to see it setting. We have done an about-turn, half a revolution, from facing East to now facing West. When graphed, the Suns trajectory appears to be approximately that of two straight lines. On the first line it ascends ever higher until noon, and from this highest point, it then descends on the second straight line back down to the horizon. It depends on which circle the Sun is currently orbiting and the position of the observer, as to exactly how high the Sun will appear to climb.

As the Sun moves across the sky, it always appears to us as a circle. The shape does not change. It does not vary and "shape-shift" to look elliptical. When significantly above the horizon its angular diameter is always approximately 0.53 degrees. When close to the horizon (aka further away) its apparent size and sometimes shape does vary depending on many factors, such as position and altitude of observer, the Suns position on its circle spiral, the medium in which the light propagates and its refractive, reflective and diffractive properties.

When an observer increases their altitude the Sun is more readily seen to shrink when setting, but it does not necessarily change its figure in any significant way. It gets smaller but remains a circle. If vision is impacted by atmospheric conditions or acquired perceptions create a belief of a certain knowledge, then the size can appear to increase or become misshapen.

Globeheads say that these observations are only possible if the Sun is very big and very far away, so that light rays are assumed parallel to each other. (Note: This is the same basic concept as an orthogonal projection, where rays from the object are assumed perpendicular to the plane of the object, arriving as parallel lines at the eye).

They say the flat earth model must be wrong because it contradicts the laws of perspective. Perspective, they say, dictates that when an object on a parallel plane above our heads distances itself, it must also shrink. In addition, they say that its shape must become that of an ellipse, since it is being seen obliquely as it sweeps above us permanently changing its direction.

We will address two questions. 1) Why does the Sun not shrink when it distances itself from us and 2) Why does it not change its shape (at least not visibly)?

The first question is not so difficult.

1.2. Why does the Sun not change size when it distances itself?

It should shrink as it goes further away and get bigger when closer, according to the laws of perspective. Well the simple answer is that it does do this.

There is abundant evidence of the Sun getting smaller as it recedes. Altitude plays a role in this. The higher your eyes are, the more “shrink” can be witnessed. This is not so easily witnessed at sea level or when on the ground, where the path of the Sun is obstructed by the ground plane rising to the eye level horizon quicker than the parallel plane on which the Sun moves. The Sun therefore stays the same size in normal atmospheric conditions and sinks from view, below the horizon bottoms ups, before any significant size change can be witnessed.

The second question requires more explanation.

1.3. So why does the Sun not change shape into an ellipse?

It should they say, because if you stand directly under a circle, drawn on a parallel plane above your head (e.g. ceiling) or directly view a circle drawn on a wall, then it appears as a circle, but when you distance yourself from them then the circle changes into an ellipse.

The argument is then, that since we never experience this, the Sun cannot be a circular disc orbiting overhead on a parallel plane and if, as in the flat earth model we assume the Sun orbits in a parallel plane, then it can only be a sphere, because only a sphere always appears circular when viewed from any direction or distance.

Is this true? Can only a sphere appear circular? Are there geometrical positions where a flat circular disk will appear as a circle to those viewing below? When does a flat circular disc appear as a circle, when as an ellipse? Are there particular positions of the eye, where it appears as one or the other?

Euclids Optics contains theorems (34, 34a and 34b) relevant to this question They are not difficult to understand and since they are essential for what follows, I show them here in full.

The original blue italic text is the English translation of Euclids Optic by XXX in 1950. I have added some geometric diagrams to assist the visualization.

Note to me: Experiment: Do the experiments with all 3 of Euclids Theories. A circle 10 feet diameter on a wall or on the ground. Draw the circle with 2 perpendicular diameters. Attach a 5-foot radius length of to the centre. Photograph from any point at the length of the string.

The first case where a circle appears as a circle, is the one that everybody knows and most assume to be the only valid scenario.

Euclid Optics - Theorem 34

If a straight line is erected from the center of a circle, at right angles to the plane of the circle and the eye is placed upon this, all the diameters crossing upon the plane of the circle will appear equal.

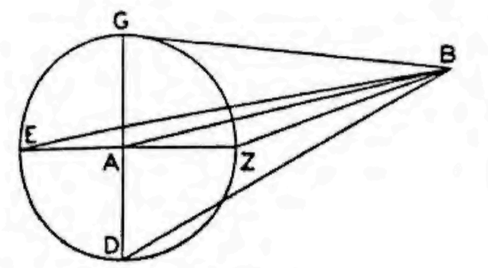


FIG. 34.

Proof: Let there be a circle, the center of which is the point A, and from it let the line AB be erected at right angles to the plane of the circle, and upon this let the eye B rest. I say that the diameters will appear equal.

Let there be two diameters, GD and EZ, and let the lines be drawn BG, BE, BD and BZ.

Now since ZA is equal to AG, and AB is common to both of them, and the angles ZAG, BAZ, BAG are all right angles, then the base ZB is equal to the base BG, and the angles at the bases are equal (BZA = BGA).

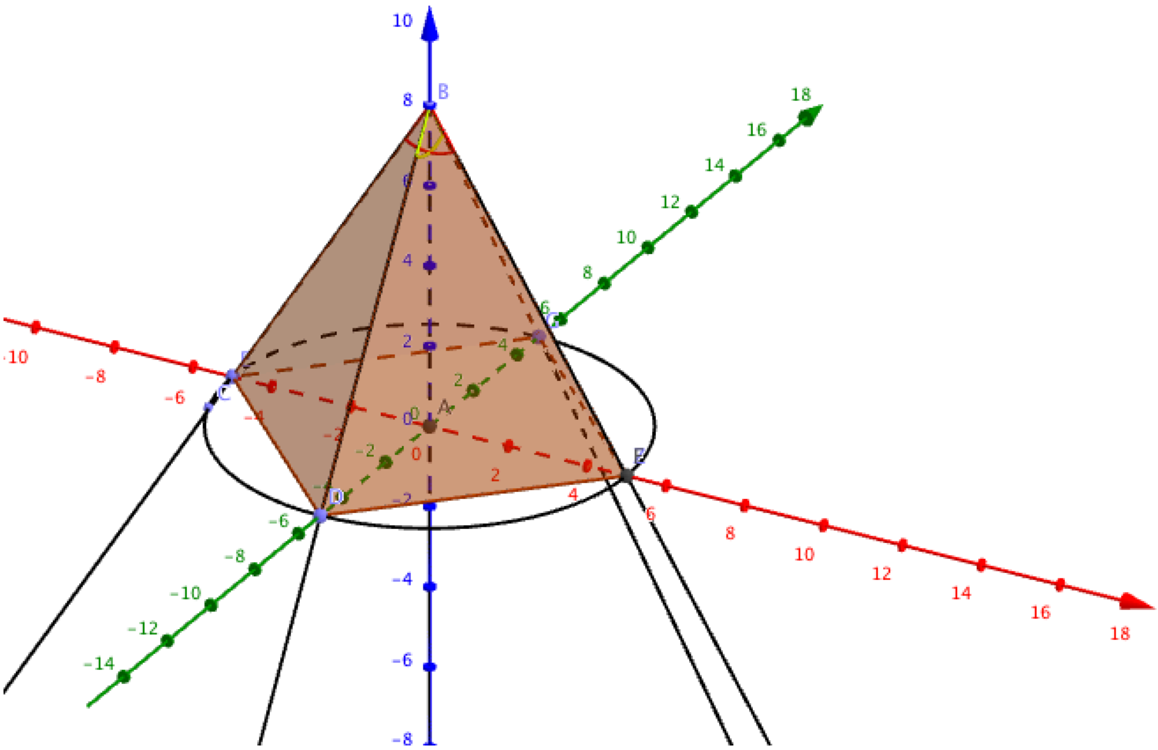
So the angle at ZB, BA (ZBA) is equal to the angle at AB, BG (GBA). Similarly, the angle at EBA is equal to the angle at DBA. Then the angle at GB, BD (GBD) is equal to the angle at EB, BZ (EBZ).

QED.

Euclid – Theorem 34 – VP Comments

This case is obvious and intuitively true. If you are centred and perpendicular over the circle at all times, the perimeter/boundary line of the circle is equidistant at ALL points, so that any diameter will appear (angle subtended at the position of the eye), equal to any other diameter, and hence it is always seen as a circle. Note: That this applies equally well if the circle is above us, or directly facing us on a wall.

If the altitude of the eye (on the blue Z Axis) is varied, the size of the circle will change and become smaller or larger, but its shape stays the same. All diameter lengths appear in a ratio of 1:1, and appear of equal magnitude.



The vertical and horizontal diameters are seen under equal angles, so they are in a ratio of 1:1. So their magnitudes will appear in the same ratio and so they will appear to be of equal length.

The next case deals with viewing a circle "off-centre" or from an oblique position, but at a distance (altitude or height) equal to the radius of the circle.

Euclid Optics - Theorem 34a

And if the line drawn from the center is not at right angles to the plane, but is equal to the line from the center (that is, is the radius of the circle), all the diameters will appear equal (Fig. 34a).

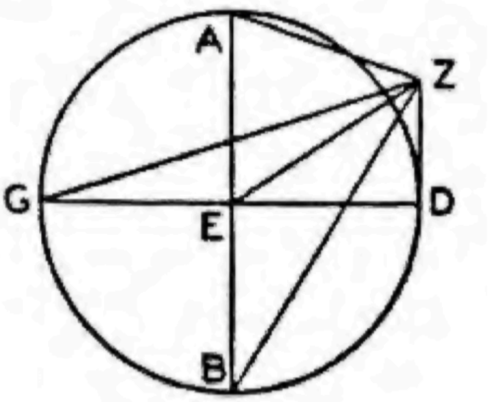


FIG. 34a.

Let there be a circle, ABGD, and in it let two diameters be drawn, AB and GD, and, leading from the point E, let there be a line, ZE, upon which is the Eye Z, not at right angles, but equal (in length) to each one of the lines (radials) from the center, and let the rays be drawn, ZA, ZG, ZB and ZD.

Now since BE is equal to EZ, but also AE is equal to EZ, the three lines, EZ, EA and EB are equal. So the semicircle drawn in the plane through AB and EZ about the diameter AB will go through Z. So the angle at AZ, ZB (AZB) is a right angle.

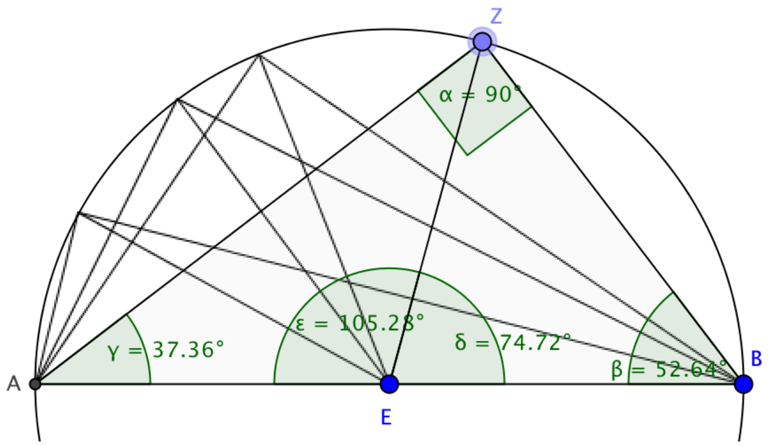
Similarly, also the angle at GZ, ZD (GZD) is a right angle. The right angles are equal and things seen at the same angles appear equal.

So AZB will appear equal to GD.

QED.

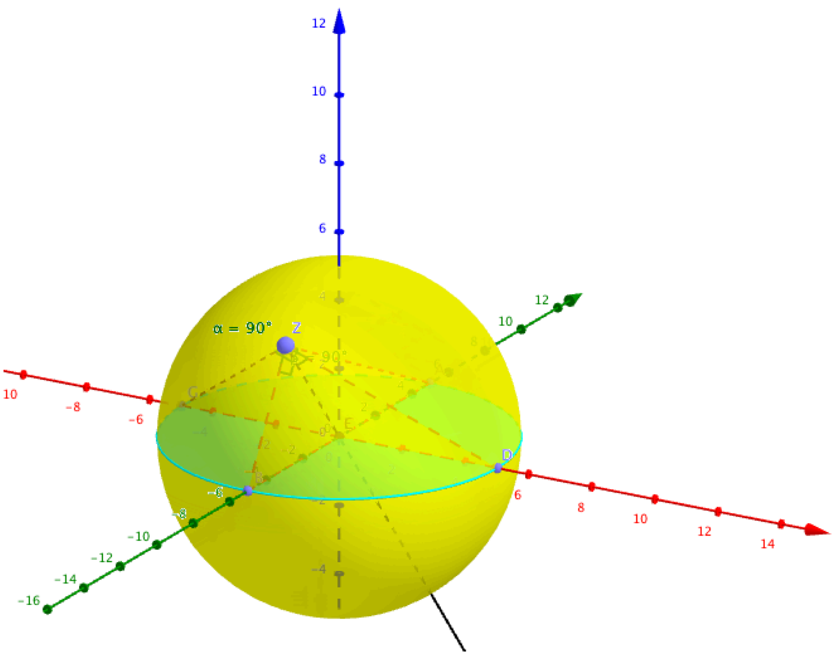
Euclid – Theorem 34a - Comments

This is the special case where the distance of the eye at Z, from the centre of the circle at E, is equal to the radius of the circle. A circle can always be drawn through any 3 points, and if A and B are also equidistant from E, then Euclid uses the fact, that the angle at Z must then always be a right angle and so Z is then any point on the arc of a circle/semi-circle.



If the circle is considered to be a cross section of a sphere, then the perimeter line of the circle is part of the surface of the sphere. All cross sections of a sphere are identical, so the entire surface of the sphere is made from the perimeters of many circles, all centred on E. (This is the basic definition of a great circle on a sphere).

Seen in 3 dimensions, the distance being equal to the radius means that the point Z must be on the surface of a sphere. We have seen above in Euclid 34a, that then the angles subtended at Z are always right angles, and in addition the point Z is always equidistant from the centre.

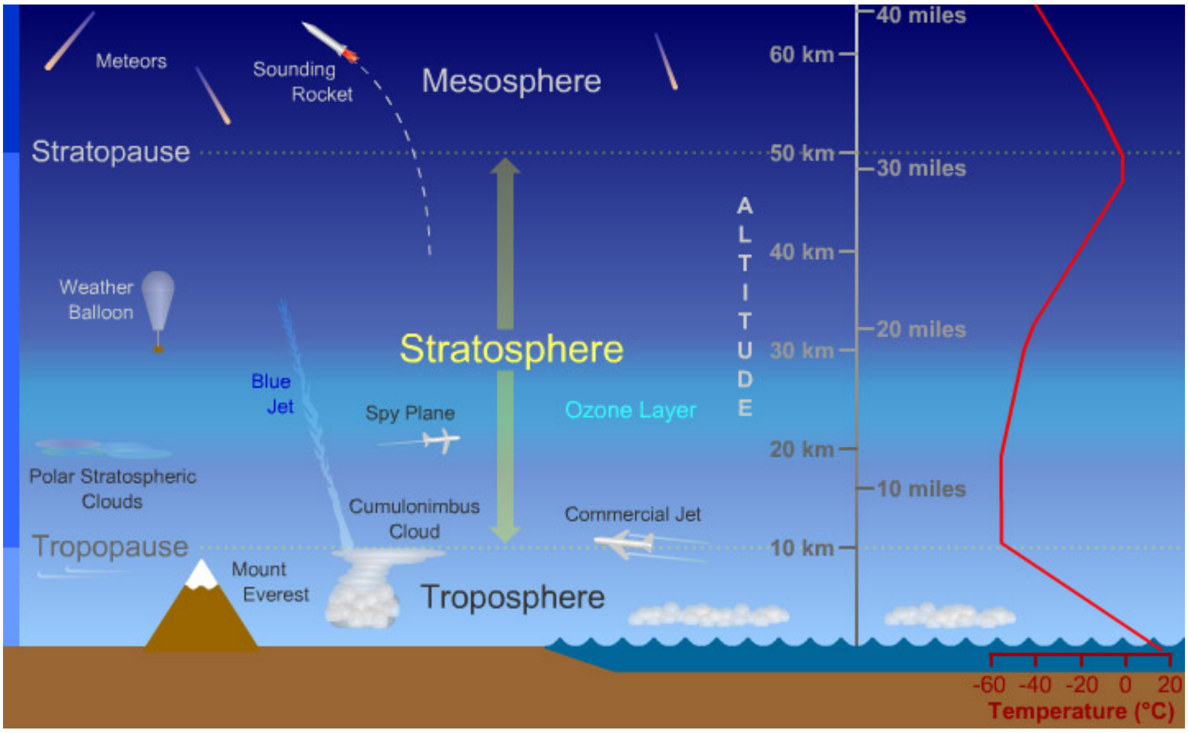


So the point Z on the perimeter of the circle, can be anywhere on the sphere and the angles subtended at the eye by the perpendicular diameters (GZD and AZB), are both right angles and hence equal to each other. The magnitudes are then in proportion to the angles, so that the diameters also appear of equal length. Hence the circle appears as a circle.

Note: If the circle had a diameter of 10 units, and is lying on the ground, then Z can be 5 units distant at every point, so a sphere of radius 5 units, with its centre the same as the centre of the circle, would be a valid model.

If the Sun is taken to have a radius of 16 nautical miles, then Z must also be at 16 nautical miles for the circle to ALWAYS appear as a circle.

Nautical miles	Statute Miles	Feet	Kilometres
16	18.4125	97.217	29.632
32	36.8294	194.436	59.264



In a flat earth model, an altitude of 16 nautical miles would “seem” to be too low. However, since we know space is faked, and we can’t trust anything a government agency tells us, this option cannot currently be fully discounted.

We will return to this scenario later, remembering that the EYE sees AS IF it were at the centre of a sphere.

The 3rd case of Euclid is where Z is situated obliquely and at a distance NOT equal to the radius. However, we must restrict the case to where the “enclosing angles” are equal.

Euclid Optics - Theorem 34b

But let AZ be not equal to the line from the center (that is, the radius), and not at right angles to the plane of the circle, but let it make equal the angles DAZ and ZAG, and the angles EAZ and ZAB. I say that even so the diameters making the equal angles will appear equal. (Fig 34b)

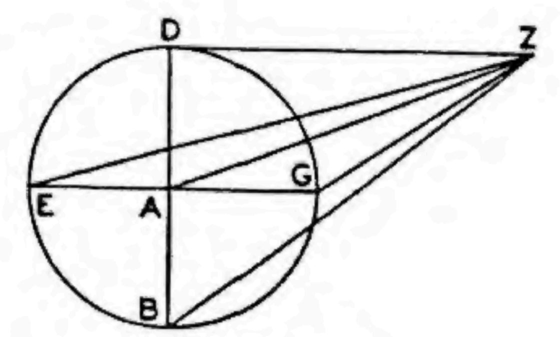


FIG. 34b.

For, since GA, AZ are equal to ZA, AD, and since BA, AZ are equal to ZA, AE, and since the angles are equal, then the base DZ is equal to the base ZG; so that also the angle DZA is equal to the angle AZG.

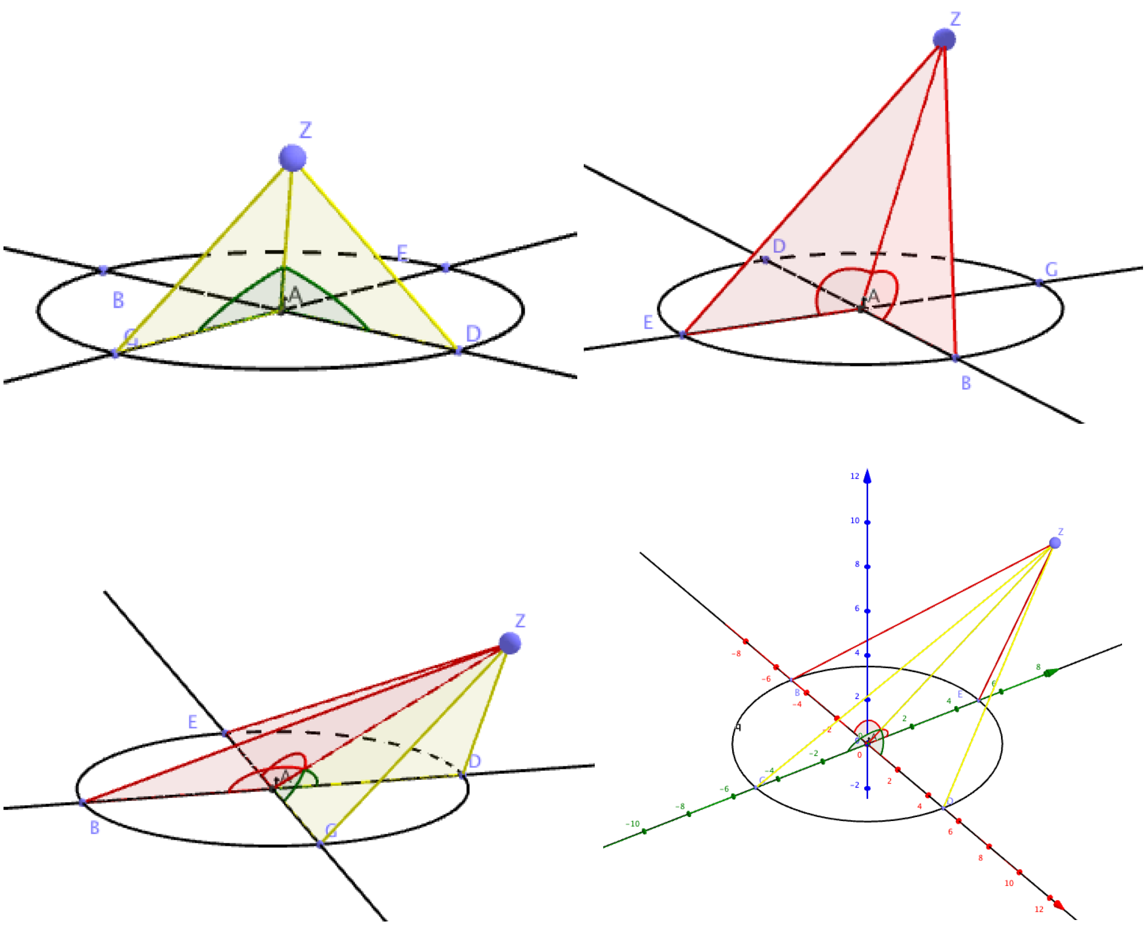
Now similarly we shall show that also the angle EZA is equal to the angle AZB. So, the whole angle DZB is equal to EZG. So that also the diameters DB and EG will appear equal.

QED.

Euclid – Theorem 34b – Comments

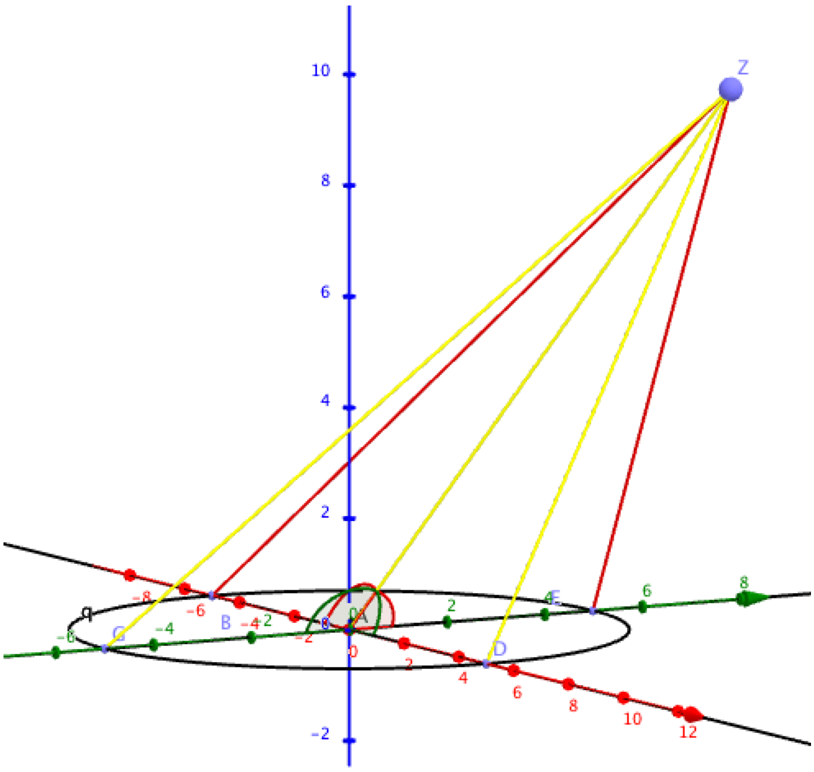
This is represented in “3 dimensions” below. The eye at Z is above the ground plane on which the figure of a circle lies. Rays are drawn that connect the object extremes, any two perpendicular diameters (DB and EG) of the circle, with the eye. There is also a direct line connecting the eye at Z, and the centre of the circle at A.

The circle is divided into 4 quadrants by the perpendicular diameters. The “enclosing angles” are the angles enclosing a specific quadrant.



If the green angles (between the yellowish green lines) are equal to each other and also the red angles (between the red lines) are equal to each other, then the sum of any green and red angle will be the same as the sum of the other red and green angle. Adding cross wise gives the same sum. Adding a green and a red angle gives the total angle subtended at Z by a complete diameter.

This case where the green angles are equal to each other and the red angles are also equal to each other, is a necessary condition (that “enclosing angles” are equal) for this scenario to be applicable.



This means the angles subtended at Z, of both diameters BD and GE, will be the same (the sum of a red and a green angle). If these angle sums are the same, the diameters will appear of the same magnitude. If the magnitudes appear in the same ratio to each other (1:1), then the figure appears as a circle.

QED.

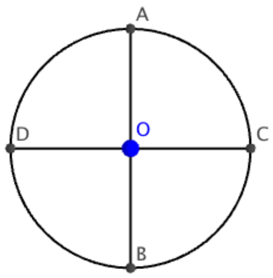
So our query reduces to answering the following question. At which positions of Z, are both green angles equal and both red angles equal?

(And consequently, by the theorem above, the perpendicular diameters of the circle will be seen equally).

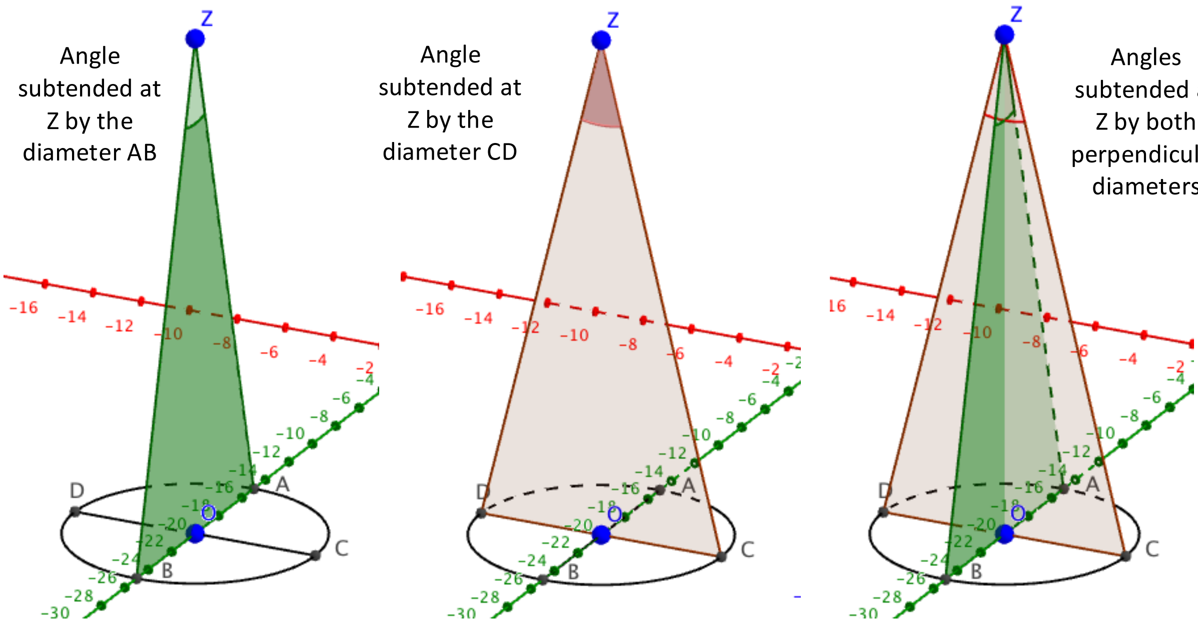
When is a circle a circle?

A thought experiment: Riding the Sun Circle

Suppose a circular, opaque disc ABCD with centre O and radius OA, lying flat on the XY ground plane. The disc has two perpendicular diameters AB and CD, lines joined with the corresponding points A, B and C, D. The diameters of a circle are always of equal length, so that AB = CD.



Suppose also a point Z, situated directly above O, at any distance. A straight line connects O and Z. The X-Axis is red, the Y-Axis is green and the Z-Axis is blue.

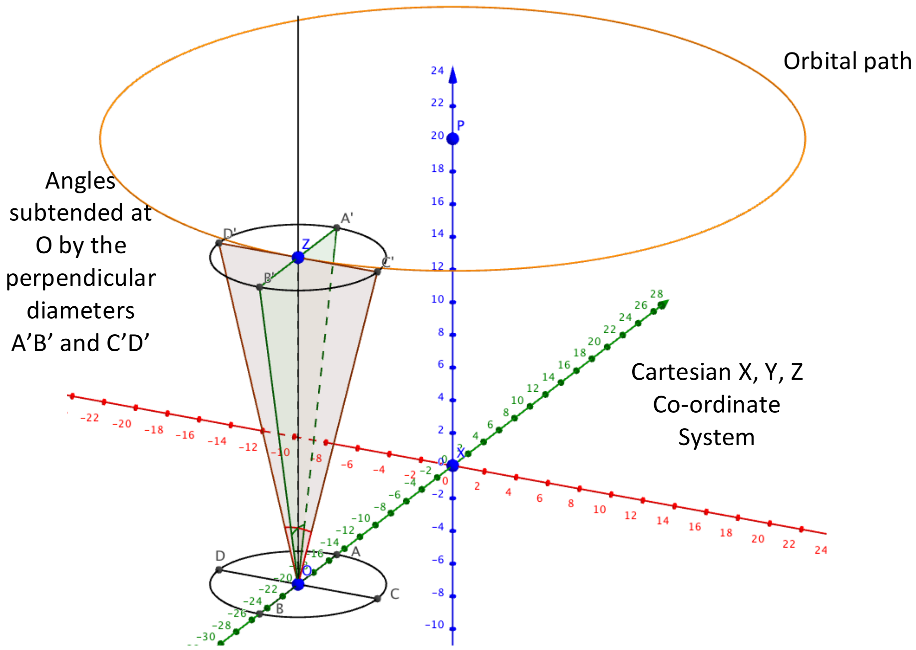


If a circle is to <u>appear</u> as a circle, then any two perpendicular diameters must subtend equal angles at the eye, in order to <u>appear</u> of equal length. (See Euclid Optics 34b).

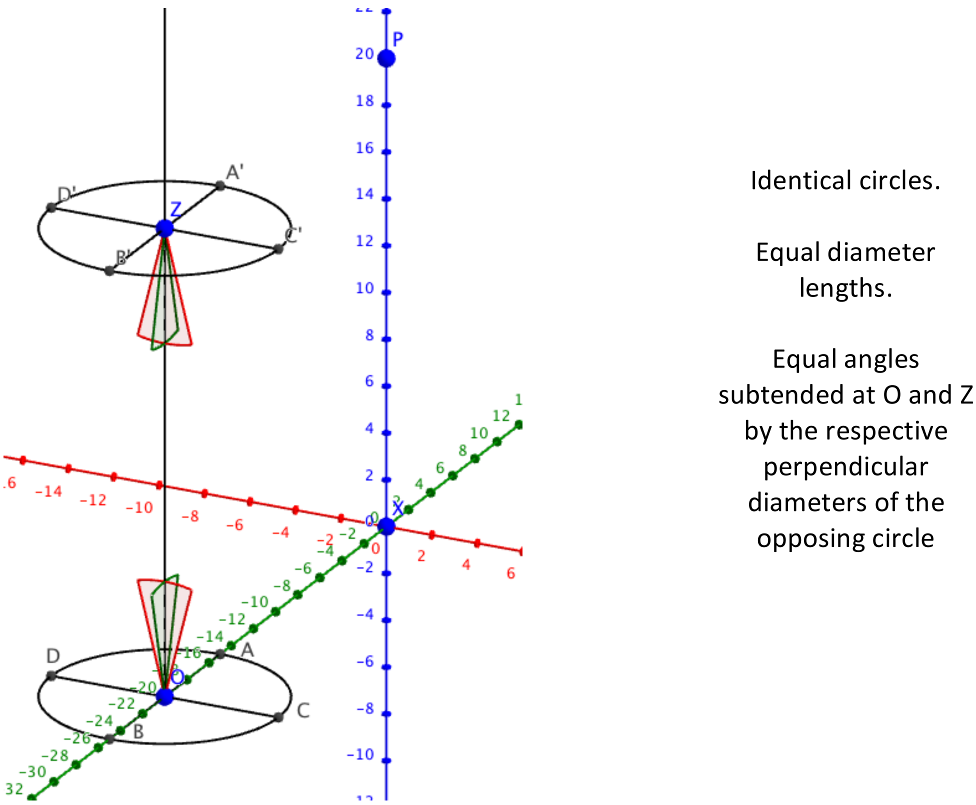
By drawing straight line rays from Z to each of the diameter extremes (endpoints), we can visualize this as in the 3 figures above. The green angle and the red angle will be identical if ABCD is a circle and if they are equal, then ABCD must be a circle.

Suppose further, that Z is also the centre of an identical opaque, circular disc with diameters A'B' and C'D' that are perpendicularly above their counterparts on the circle below.

Then we can similarly draw rays from O to the diameter extremes of the circle A’B’C’D’ and similarly the angles subtended at the point O will be equal if A’B’C’D’ is a circle.

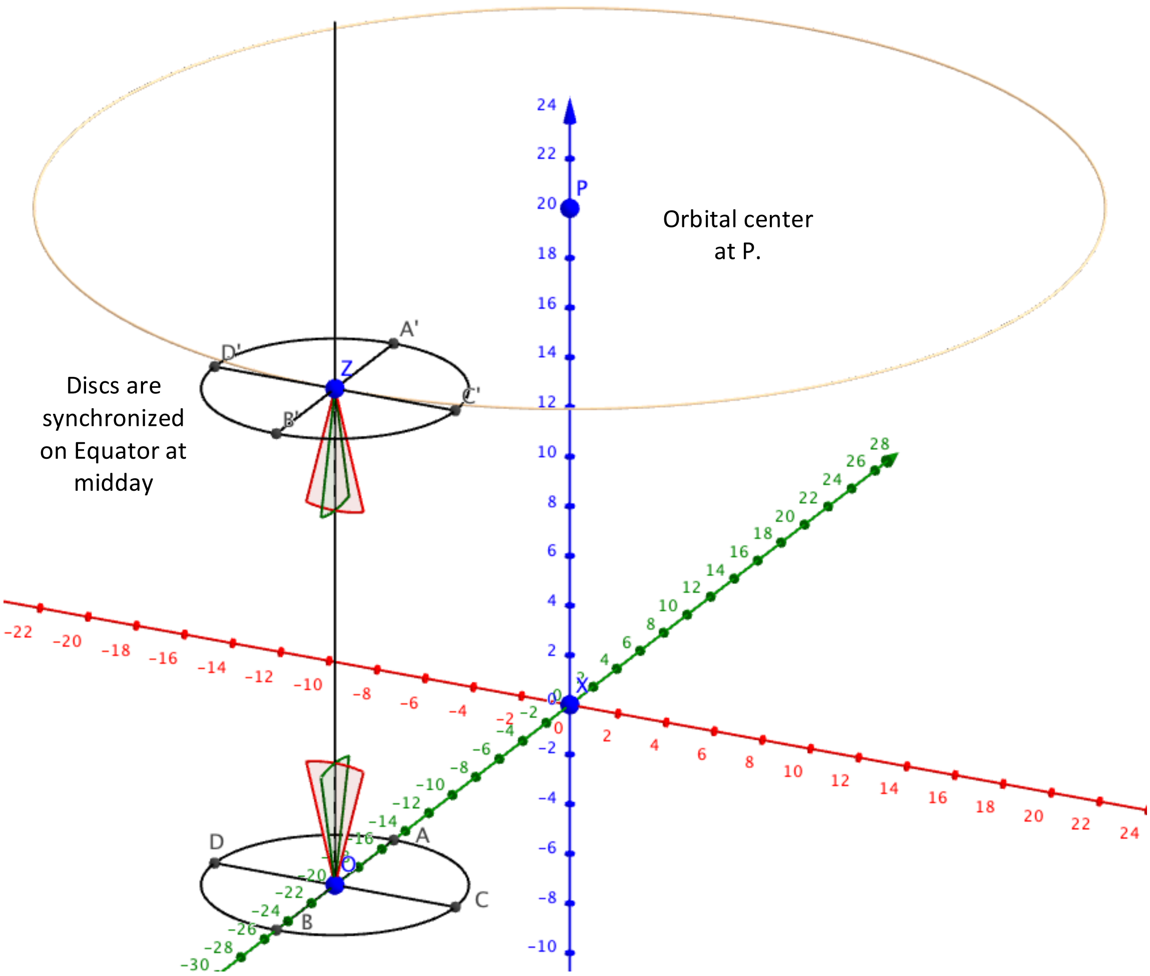


So we have two identical circles, 4 equal diameters and in this position, “directly over each other” we also have 4 equal angles subtended by the diameters of the circles (Euclid 34).



Note: Diagrams are NOT to any specific scale, but only for purposes of geometric demonstration.

The point Z is further constrained to move only on the perimeter of a larger circle (orange orbital circle) that is centred on a point P, which is directly above the origin at X.



At this starting position, directly above each other, the two discs are in a sense "synchronized" with each other.

This initial configuration represents a position O on the Equator, on the day of an Equinox either March or September 21st, with the center of the Sun at Z, directly overhead at midday. The point O can be any point on the equatorial circle that lies on the plane XY.

We have a dual situation:

1) an eye at Z is orbiting around the point P in a plane parallel to the ground plane, and viewing a fixed circle ABCD below
2) an eye at a fixed point O, is looking up at a circle A'B'C'D', orbiting P in a plane parallel to the ground plane.

The relations and ratios of the objects and their points, lines, angles and distances with respect to the eye (when in positions O and Z respectively) are the same (when viewed from O or Z).

We will make use of both points of view to gain a better overall understanding.

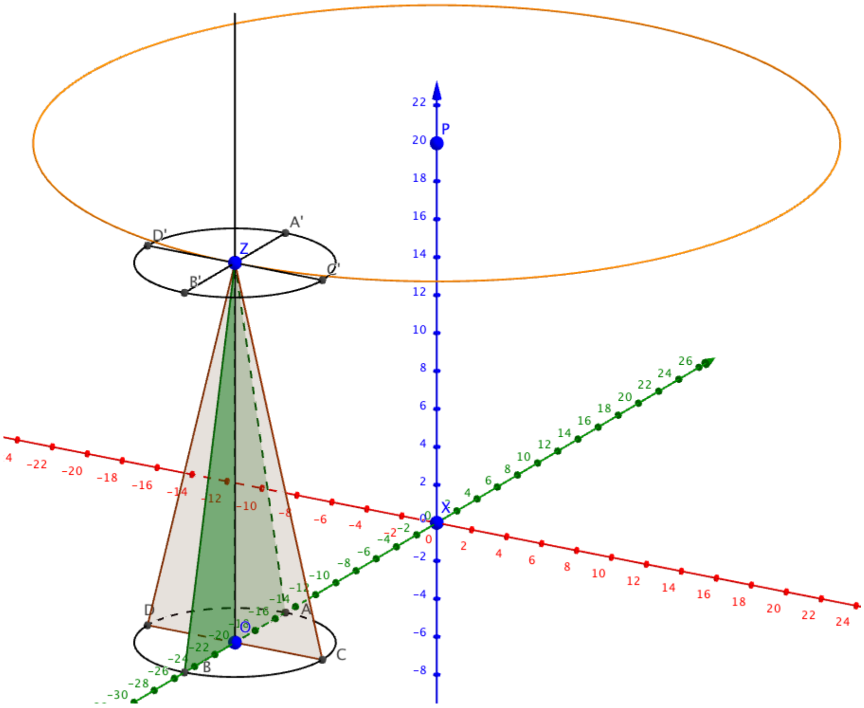
Suppose an observer is riding on top of the flat disc Z. The disc is opaque, so we cannot see through it. If the observer crawls to the point A' and looks directly down, they will see A below. Likewise, if they look down from points B', C' and D' they will see B, C and D respectively, directly underneath.

Suppose also that at the point Z, there is a small hole in the disc for an eye to look down at the circle. The center O will be seen directly below and the whole circle will be seen in the visual field similar to looking through a pinhole.

The diameter extremes A, B, C and D are equidistant from Z, so that the diameter lengths will be visibly equal. (Euclid Optics 34).

Depending on the altitude of Z, the circle below at O, will appear smaller or larger to the eye, but will have a circular shape since Z is directly over the center O of the circle. If we decrease the altitude of Z the eye sees the circle larger and if we increase altitude, it will appear smaller (Euclid 34).

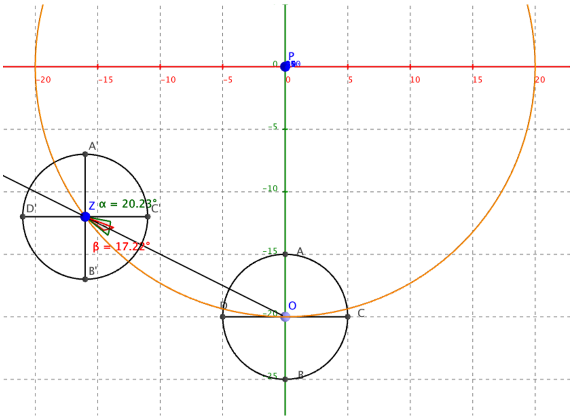
So with Z constrained to move on the perimeter of the large orbital circle and initially directly above O, let's ride the Sun circle, looking down at the circle on the ground.

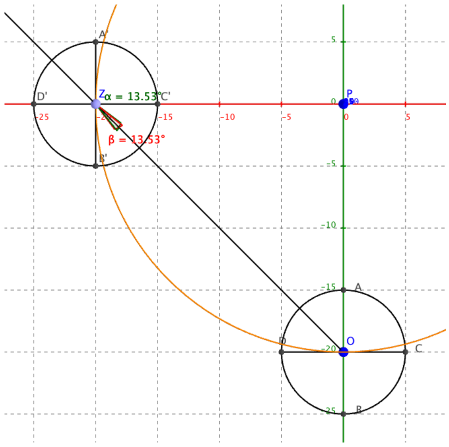


We will let Z orbit clockwise. (This would correspond to a Sun moving West, from the point of view of a stationery observer at O, facing the origin at X.)

In the next diagrams, we are looking at the new geometrical arrangements from above, in a plan view, where Z has completed an eighth (45 degrees) and a quarter (90 degrees) of a complete orbit.

The angles are no longer equal at an eighth, but they are equal again at a quarter, albeit smaller than when directly overhead, due to the increased distance.



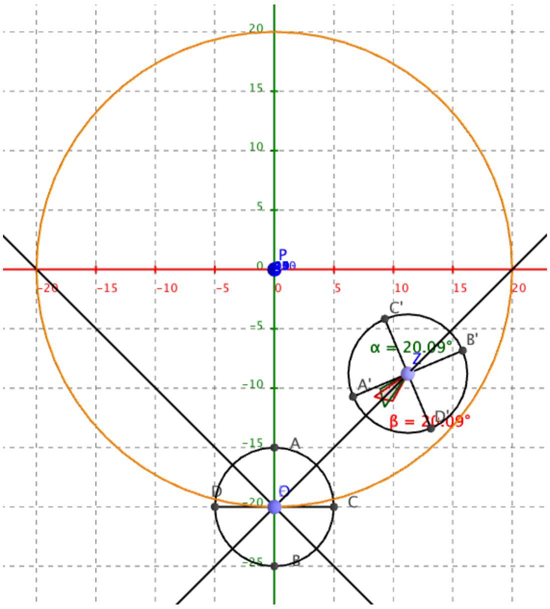


The diameter angles as seen from Z, are only equal at three points on the circular orbit. At any other orbital position, the angles are unequal.

So the circle appears smaller with increasing distance and its visible figure changes to an ellipse with increased obliqueness of Z to O, i.e. how much off-centre they are with respect to each other. By "off-centre", we mean the displacement of Z from O, measured in the XY plane. An example would be 20 units towards X and also 20 units left of X as in the diagram above on the right.

Only when they are off-centre in equal amounts are the "enclosed diameter angles" also equal.

This is true for any point on the lines Y=X or Y=-X, with origin at O. However, only one point on each line also lies on the orbital circle. These are the three "intersection" points. Sunrise in the East, midday overhead, and Sunset in the West.



Side-Note: Moving on the line Y=X is close to being a representation of the Suns path as it rises vertically in the East, moves overhead to O, then moves on Y=-X to sink vertically in the West, but <u>this cannot</u> be the <u>real path</u> of the Sun. It circles above the ground plane illuminating a finite area below. It does not travel in a straight line.

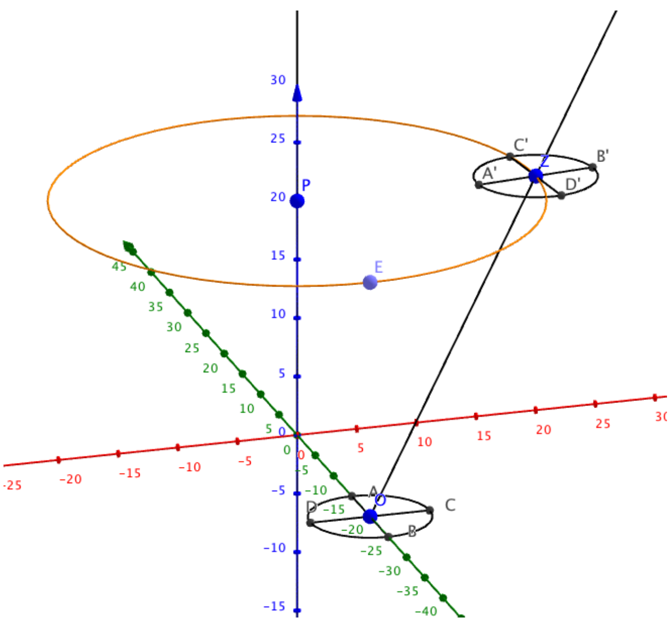
So we would seem to have a problem in the flat earth model - of a sun disc orbiting in a circle around Polaris, in a parallel plane to the ground – because the "enclosed diameter angles" of the circle don't stay the same. So it seems we cannot use Euclid 34b and that we must say:

1) A flat disc moving in a circular orbit cannot be the real path of the Sun, since it would never be a circle, but rather always misshapen (elliptical), except at three times of the day (at sunrise, midday and sunset). This <u>does not</u> correspond with our experience.

2) Moving on a line (Y=X or Y=-X) also <u>cannot be the real path</u> of the Sun, since this would mean it zig-zags all over the sky, since the line Y=X is different for each individual observer on the equator or elsewhere. This also <u>does not</u> correspond with our experience.

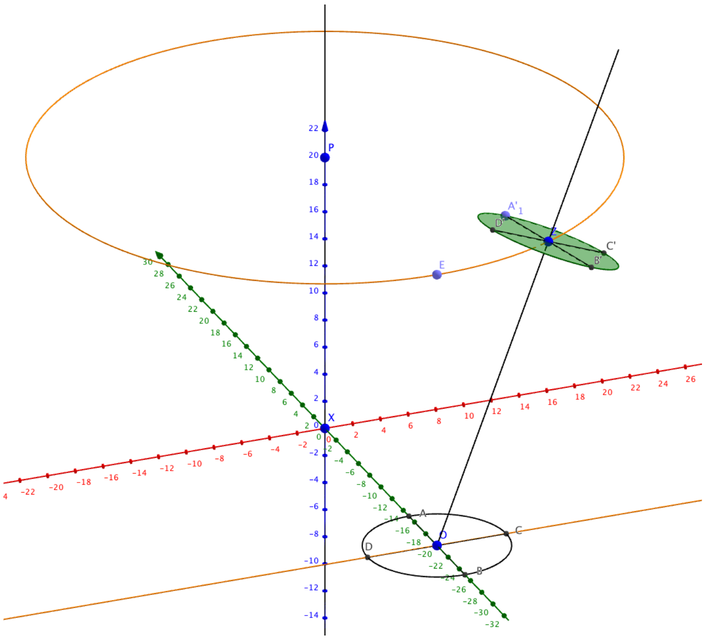
So the planar flat earth model with the Sun as a circular disc and not a sphere (aka space ball) does not seem to work? Or does it? Is our geometrical model correct or do we need to modify it somehow?

Let's investigate further. Z is again on the orbital circle and due East of the observer at some position in its orbital path. E is the initial point directly overhead at midday of an observer at O.



If an eye at Z now looks through the hole in the disc, it will <u>not see</u> the circle at O, since it is <u>no longer directly above it</u>. **This is self-evident, <u>because if an eye does not look directly at an object, it can never see it</u>.**

To see the circle at O, the disc at Z would have to be tilted and rotated, so that the eye at Z, has direct vision, a clear line of sight to the object. In the case of the Sun this cannot be correct, since it cannot possibly tilt and rotate for all observers at all positions simultaneously.



The disc at Z is now tilted and rotated.

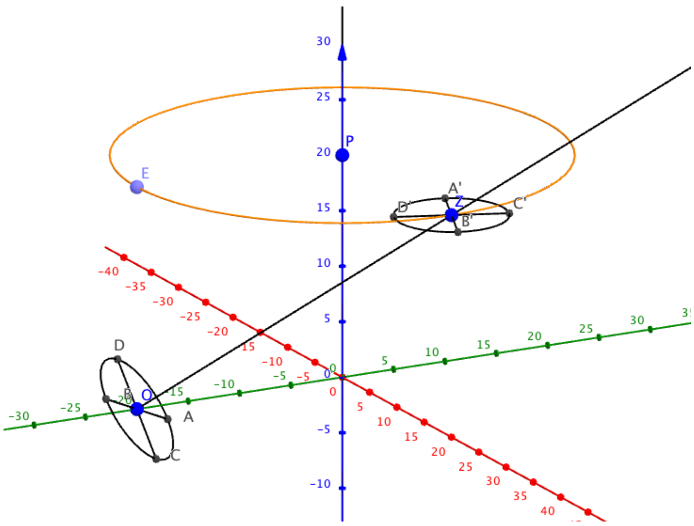
Its axis is no longer parallel to the Z-Axis as in the previous diagrams.

Its axis is now the straight line joining O and Z, the direct line of sight.

This change in axis has caused the disc at Z to tilt and rotate in the geometrical model.

BUT, we can also think about this the other way, namely from the point of view of the observer at O. Then the eye at O is looking at a flat circle centred at Z. Let's imagine an eye at O to have a fixed "hula-hoop" around it, representing a disc that can rotate and tilt, as we change our optical axis with the angle or rake of our head.

Now what is happening when we watch the circle orbiting all day? During the course of a day (or complete orbital revolution), an eye at O, will tilt up and down and will also rotate 180 degrees (more or less, between 140 to 220 degrees, depending on location and time), from East to West, to see the sun disc at all times. The eye must tilt and pan left or right to see the sun disc/circle. **This is exactly what we do when we view the Sun during the course of a day**.



We change the orientation of our eye in 3D space and the direction in which it points, when we view an object.

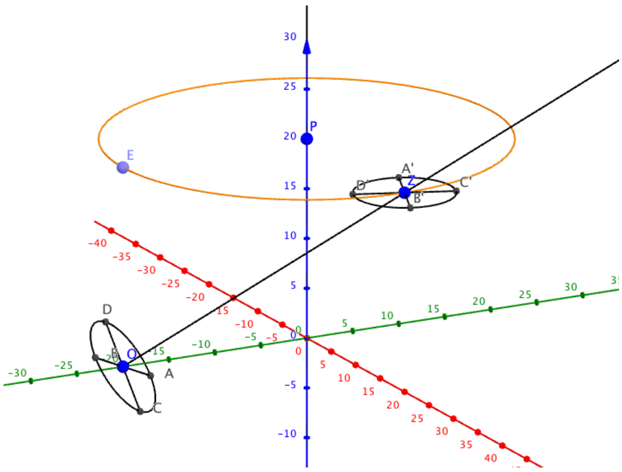
The disc at O is now tilted and rotated to reflect the reality of an observer taking a bearing or direct line of sight.

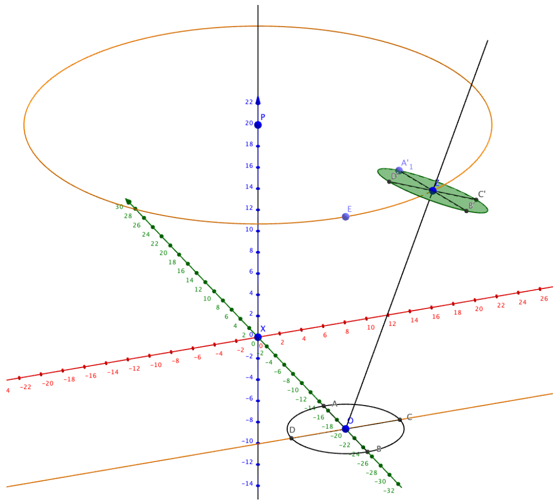
This is how we experience vision. We, the observer, change the rake / angle of our head and eye to look at an object directly and thereby align our optical axis.

So we must include this real tilting and rotating of an observer in our geometrical model. We must rotate and tilt one of our circles in the geometrical model constantly during a day / the duration of the suns orbit, to correctly model reality. So we can either:

1. Set the direct line of sight between O and Z, to be the axis of the ground circle.
   OR
2. Set the direct line of sight between O and Z, to be the axis of the sun circle.

When we do either of these changes then the results look like one of the two previously shown diagrams, repeated for convenience below. On the left we have tilted and rotated the O circle. On the right we have tilted and rotated the Z circle.





Either way of looking at this gives the same geometric results, BUT it is the diagram on the left that correctly models reality. It corresponds to the eye at O tilting and turning with respect to its initial position (of lying flat on the ground looking directly up) when it was synchronized at an Equinox.

As the point Z (and its associated circle) moves away from the initial position at E, we must lift our head (tilt) from the ground and look left or right (rotate). The point E is the intersection of the orbit with the perpendicular drawn at O, the axis joining both circles when synchronized on an Equinox.

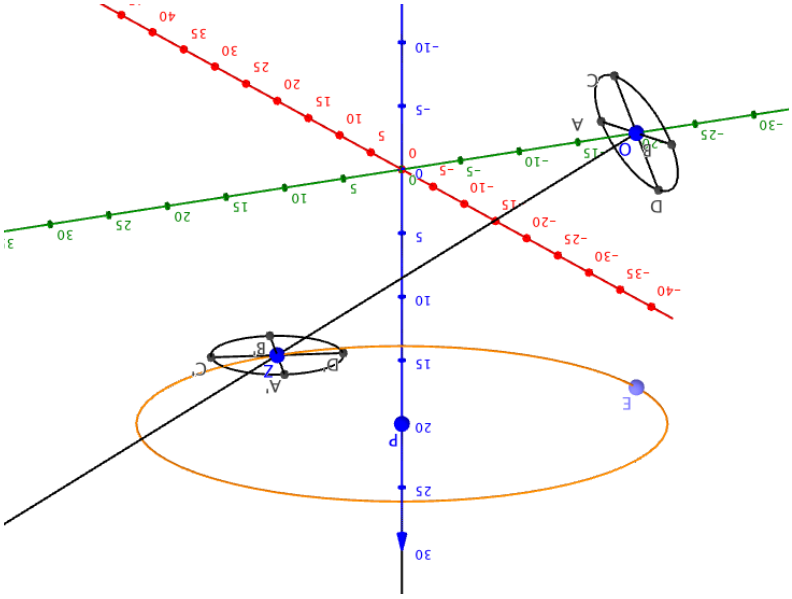
When we let Z move in an orbit in our geometric model, the "enclosed diameter angles" subtended at O are now always equal, albeit smaller or larger depending on the position of Z on its orbital path and its increasing or decreasing distance from O.

An eye at O always see a circle up above, since the disc at O tilts and rotates with respect to the OZ axis which joins O and Z.

Diagram missing of "equal enclosed diameter angles" at O.

Another way of thinking about this is <u>by turning the picture with the tilted O circle upside down</u>. We put the Z-Axis on its head, the orbital plane becomes the ground plane and Z is now a point on the ground.

Then the eye at Z will see a circle at O, since we have not changed the relative positions of the eye and the object.



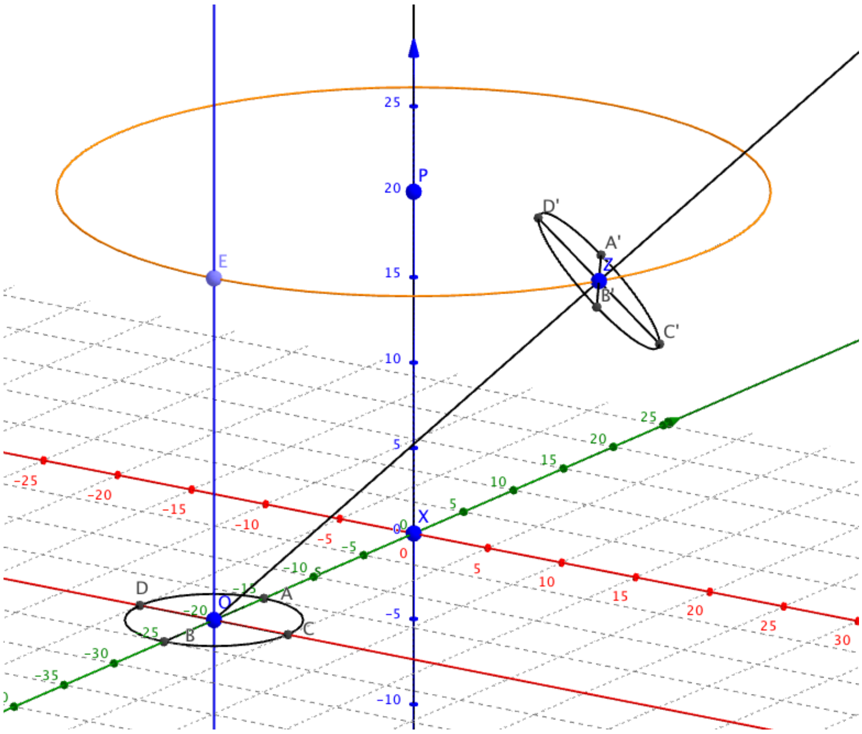
The picture of the flat disc at Z and the tilted, rotated disc at O has now been turned upside down.

If Z was to be stationery, then it would appear that the O circle is moving across the sky, but always facing us.

If we assume the frame of reference with respect to Z, as being static or absolute, i.e. Z is not moving, then a fixed eye at Z on the ground, will <u>see a circle in the sky at a certain bearing at a particular instant of time</u>, as it appears to cross the sky.

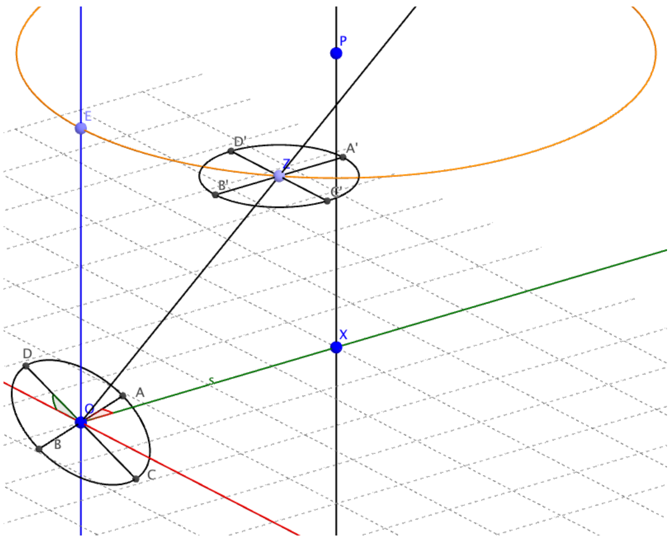
So the Sun <u>can</u> be orbiting in a plane parallel to the ground plane and its appearance will never change shape! The flat earth model <u>does not contradict what we see</u>. There is no "shape-shifting" of the Sun in this geometric model.

It <u>always appears as a circle</u> because the <u>angles that the diameters subtend at the eye remain equal</u> throughout the orbiting motion, due to our natural direct vision (aligning the optical axis of our eyes by changing the "rake" of our head by tilting and turning.



And this then corresponds to exactly what we see. The disc appears to hang in the sky and face us at all times. In reality it is of course not doing this. It only appears this way because we are changing the situation of our eye and optical axis.

The above duality shows that the angles of tilt and rotation of the disc in the sky are the same as if we had rotated and tilted the observer disc on the ground.



The angles of the diameters of the O circle (red and green angles in the O circle above) with respect to the ground plane and the observers own axis, are the familiar Alt-Azimuth coordinate system.

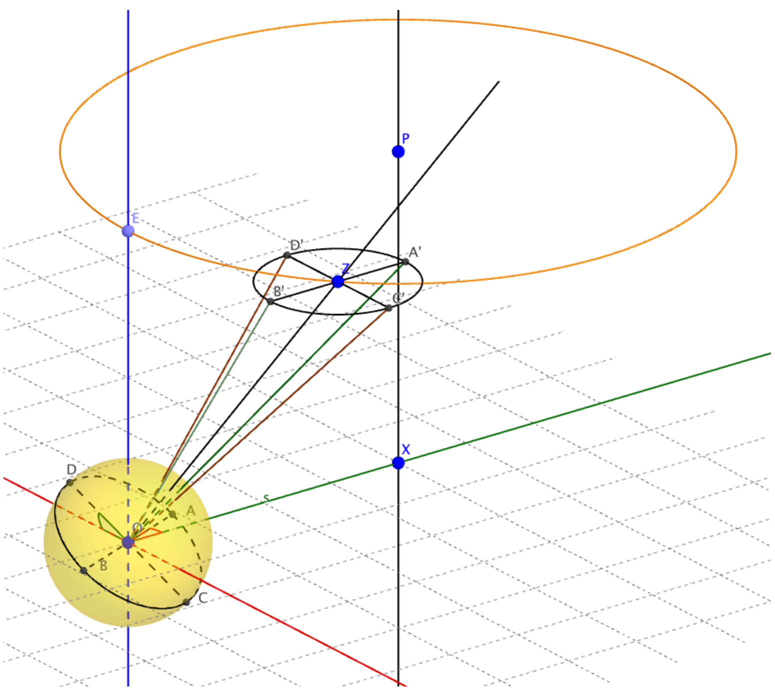
Why does the size not significantly change? This is due to the nature of our vision. The true appearances of objects are seen, AS IF, on the inside concave surface of a sphere of which the eye is the centre.

So the eye at Z (or O) sees a two dimensional arrangement of figure(s) in its horizontal X Axis (Left/Right) = Longitude and vertical Y Axis (Up/Down) = Latitude, but it cannot distinguish distance and size in the Z-Axis (Forward/Backward).

On a sphere all distances from the centre of the sphere to any point on the surface are equidistant at a distance equal to the radius of the sphere. When we reach the limit of vision which depends on the optical apparatus used and the environmental conditions, then all distances will appear equal, and therefore AS IF at the centre of a sphere (since here all distances from the centre are equal).

All points on a sphere being equidistant from the centre is equivalent to NOT being able to distinguish any difference in distance in the “outward” direction. This is also why a great circle on a sphere is a visible straight line on a plane passing through the eye. The eye cannot perceive the outward bending curviness and sees only a straight line.

The “visual sphere” of the eye behaves in exactly this way. An eye sees all points as being equidistant, when seen from its position (the centre of the visual sphere), and when distant objects are viewed that are at the limits of the visual system.

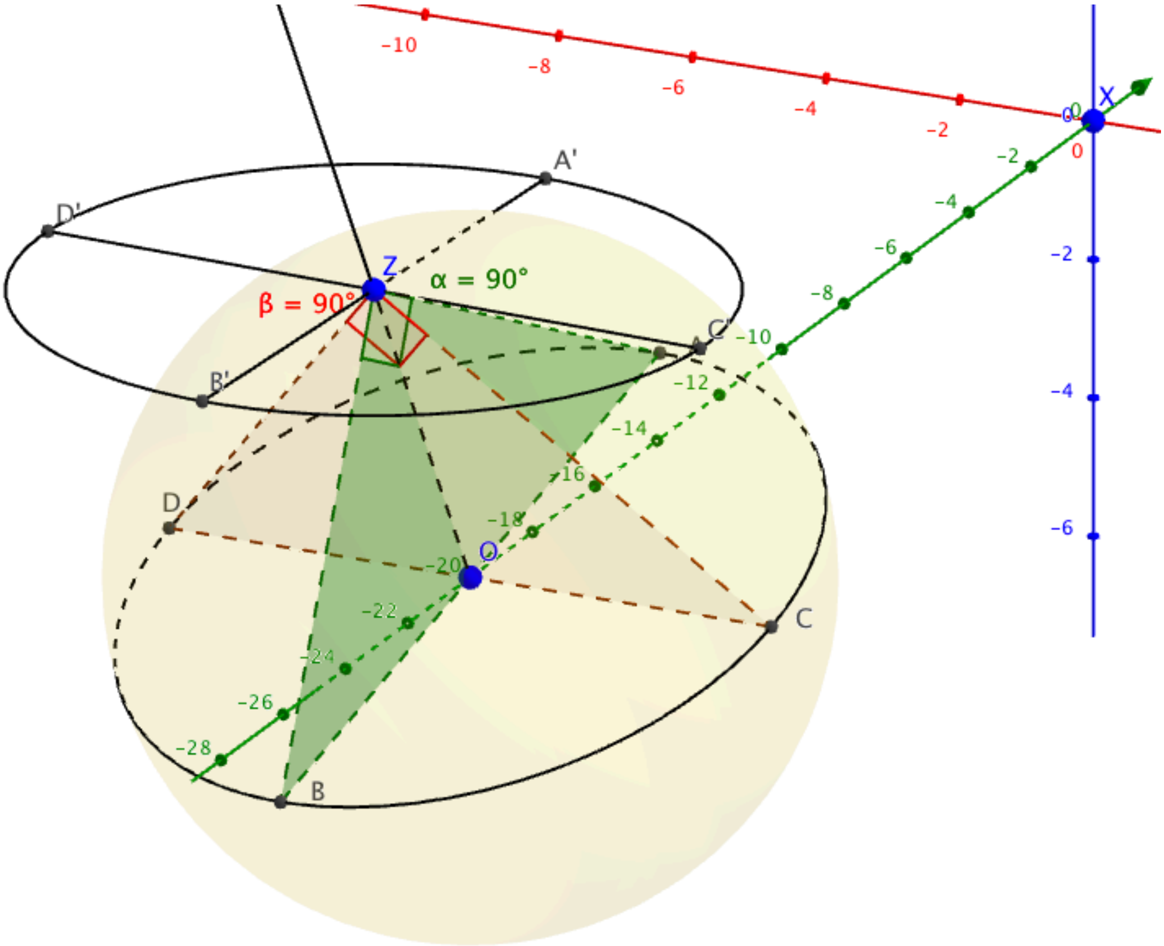


There is therefore no perceptible change in diameter length for an observer at sea level.

Note: The diagrams are not to scale, but when we use real distances the visible difference in diameter angles is very small because of the immoderate distances involved.

If the altitude of Z equals the radius of the circle ABCD, then the angles subtended at the eye at Z, will be 90 degrees, i.e. both right angles (see Euclid Optics 34a).

Note: If Z is constrained to always be at a distance equal to the radius of the circle, then it must be on the surface of a sphere, with centre O of that radius. This is depicted below.



The diameter angles at Z, are only equal at three points on the circular orbit, corresponding to two adjacent quadrants of the orbit circle from the point of view of O. At any other orbital position, the angles are unequal.

Experiment

Using a drone with a camera, find the positions of the drone and its camera where a circle appears as a circle.
On a level area of XX square meters, place a paper circle of diameter 1 meter. On this circle mark the origin and two perpendicular diameters to create 4 points on the perimeter of the circle. They are all equidistant from the origin and also equidistant from each other around the arc of the perimeter.
Fly a drone at a specific altitude, so that it circles over the circle on the ground, on a plane parallel to the ground plane. The drone must have a camera that can be pointed directly to

the origin of the circle, irrespective of the position of the drone. The drone is moved on a plane parallel to the ground plane on which the circle lies.
The drone takes pictures of the immobile circle below, at various positions during its path.
The intention is to find the positions of the drone where the picture taken of the circle below it, has equal length diameters and so appears as a circle.

Size of Area needed?
Size of Circle
Drone camera orientation?